ESTIMATION OF LARGE COASTAL SHARKS DEAD DISCARDS FOR THE US PELAGIC LONGLINE FISHING FLEET

by

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Introduction

Large coastal and pelagic sharks are frequently caught and discarded by longline vessels targeting swordfish or tuna. Earlier studies have indicated that discarded catch is often not reported in logbooks as accurately as landed catch (Cramer et al.,1997). In contrast, catch and effort data recorded by trained observers aboard longline vessels is considered to be very accurate and can be used to estimate discarded catch. Discarded catch rates for large coastal sharks (LCS) can be estimated using reported effort by the longline fleet and catch rates estimated from data collected by observers. This document describes the methodology used to estimate dead discards for the US pelagic longline fleet using logbook and observers data and provides estimates of LCS dead discards in numbers and weight for year 2004. The species included in the LCS complex are the silky sharks, night sharks, dusky sharks, hammerhead sharks, bignose shark, blacktip shark, sandbar shark, tiger shark, white shark, spinner shark, and unidentified coastal sharks.

Materials and Methods

The estimation of LCS dead discards for the US pelagic longline fleet uses data collected from the pelagic logbook program and the pelagic observers program.

(1) Pelagic Longline Logbook program (PLL):

U.S. Atlantic, Caribbean and Gulf of Mexico fishing vessels which land swordfish and tunas have been required to provide daily records of effort and catch through a logbook program since October 1986. Fishers report not only landings but also number of fish discarded at sea either dead or alive. Although a variety of gear types are represented, the predominant gear (90% of vessels reporting) is the pelagic longline gear. For analysis purposes, records from the PLL were separated into two groups: (a) longline gear targeting swordfish or tuna, and (b) longline gear with targets other than swordfish or gear other than longline. In the PLL, catch is reported in numbers and effort as total number of hooks per set.

2) Pelagic Observers Program (POP):

Since 1992, the POP have placed trained observers aboard commercial fishing vessels to record detailed information about each fishing set, the catch and the bycatch that would not otherwise be collected. Recorded information includes, among many variables, individual fish size (measured or estimated) and disposition (alive or dead), surface water temperature at gear deployment and at haulback, and set location (latitude and longitude). The low number of individuals by species in the LCS comples recorded in the POP data base precluded the estimation of discards by species.

For longline gear targeting swordfish or tuna, catch and effort files were prepared from the PLL and the POP data bases. Number of hooks and number of LCS reported as discarded dead were summed by area and quarter and used to estimate discard rates per 1,000 hooks for each data set. The areas used for these analyses are those typically used domestically (Figure 1) and are thought to correspond to different types of fishing areas and fishing effort. Total number of dead discards were estimated by multiplying the discard rate in each area/quarter by the number of hooks reported in the PLL. The discard rate selected for each area/quarter stratum was based on the number of sets observed by the POP.

(1) Area/quarter with at least 10 fishing sets observed by the POP

For those area/quarter strata where the POP observed at least 10 fishing sets, total number of dead discards was estimated by multiplying the discard rates estimated from the POP data base by the effort (number of hooks) reported in the PLL.

$$\text{Number of discards} = \text{discard rate}_{POP} * \text{effort}_{PLL}$$

(2) Area/quarter with no fishing sets observed by the POP

For the areas and quarters where no sets were observed by the POP, dead discards were estimated by multiplying the discard rate estimated from the PLL data set by the effort.

$$\text{Number of discards} = \text{discard rate}_{PLL} * \text{effort}_{PLL}$$

(3) Area/quarter with less than 10 fishing sets observed by the POP

For areas and quarters with less than 10 observed fishing sets, discard rates were predicted from the linear model:

$$\text{Ln(discard rate)} = '' + \mathit{\$}aq + \mathit{(}\text{ source } + \text{,}$$

where 'aq' is a unique identifier for each area and quarter stratum, 'source' identifies observed discard rates from the PLL and the POP, *'', $* and *(* are model parameters and *,* the error term.

Total discards in weight were estimated from length measurements of fish reported as

discarded dead in the POP. Length measurements were used to estimate average weights of dead discards for each area, quarter. When less than 30 lengths were available from an area and quarter, the average weight for the entire year was used. Length to weight conversions were taken from Kohler et al. (1995) and Scott et al. (1996). Weight estimates of dead discards in each area/quarter were then calculated by multiplying the average weight estimated from POP by the estimated number.

Results and Discussion

Seven hundred six longline sets were observed and recorded by the POP in 2004. Total swordfish or tuna directed effort, reported as number of hooks, was 6,040,880 in 2004. Table 1 shows the total number of fishing sets reported in the PLL and observed by the POP by area and quarter and the percentage of sets observed. Except during the second quarter in the SAB, where a total of 187 LCS where observed by the POP as discarded dead, the total number of LCS dead discards observed by the POP by area and quarter ranged from 0 to 21 (Table 1). Table 2 shows the number of LCS by species observed discarded dead. The night shark was the species with the highest number of animals observed discarded dead. However, 135 of the 143 observed night sharks were discarded in the SAB during the second quarter. The silky shark was the most consistently discarded dead shark. The number of blacktip and sandbar sharks observed discarded death corresponded to approximately 2.5% and 1.5% of the total number observed, respectively.

The estimated numbers and weights of dead discards and the catch rates used in each area/quarter stratum are reported in Table 3. Twenty four out of the 33 area/quarter strata had some number of fishing sets observed by the POP. Of these, only 5 strata had less than 10 sets observed (Table 1). The catch rates used to estimate the number of discards for these five strata were the catch rates estimated by the general linear model (identified in Table 3 by bold-italic numbers). Only 8 strata had not trips observed by the POP. Catch rates for these strata were estimated from catch and effort reported in the PLL (identified in Table 3 by the shaded cells). Discarded weight for all strata was estimated by using the average weight for 2004 (27 kg) except for the second quarter in the SAB that used the quarter/area average estimated from more than 30 individuals (218 individuals, 26 kg average weight). The total estimated number of LCS discarded dead (longline gear only) was 4,623 in 2004 which corresponded to 121.6 MT. The proportion of blacktip and sandbar sharks to the total observed numbers by area and quarter was used to estimate total number of sharks discarded for each one of those species. The estimated total number of blacktip and sandbar discarded dead in 2004 (longline gear only) was 113 and 79 sharks, respectively. These discards corresponded approximately to 3 MT for blacktip and 2.1 MT for sandbar.

In general, bycatch species (e.g., billfish, marine mammals, seabirds, etc.) are caught in a small proportion of longline sets. This is the case for LCS where the number of sharks observed discarded dead by the POP was, in almost all cases, small. Estimating catch rates for species with very low catches can result in estimates with higher levels of uncertainty. For cases where the catch events are rare, catch rate estimates can be obtained using a delta-lognormal approach. According to Garrison (2003), the delta estimator is more appropriate than the simple mean when catch rates are log-normally distributed and bycatch events are rare. Garrison (2003) estimated bycatch in number of marine mammals and sea turtles for the US pelagic longline fleet using this method. The potential use of a delta-lognormal approach to estimate number of discarded sharks by the US pelagic longline fleet will be assessed in the near future.

References

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Table 1: Number of sets reported in the PLL (PLL sets), number of sets observed and recorded by the POP (POP sets), percentage of sets reported in the PLL that were observed and recorded by the POP (% observed), and number of LCS discarded dead recorded by the POP for each area/quarter stratum.

Area	Quarter	PLL sets	POP sets	% observed	No. sharks observed
CAR	1	235	23	9.8%	3
	2	87	16	18.4%	1
	4	16			
GOM	1	986	92	9.3%	3
	2	1507	85	5.6%	6
	3	1140	86	7.5%	8
	4	1023	73	7.1%	21
FEC	1	252	30	11.9%	8
	2	121	3	2.5%	1
	3	81	11	13.6%	1
	4	35	4	11.4%	0
SAB	1	136	1	0.7%	1
	2	523	37	7.1%	187
	3	134	14	10.4%	12
	4	72	5	6.9%	4
MAB	1	68	13	19.1%	1
	2	147	18	12.2%	5
	3	292	25	8.6%	7
	4	539	35	6.5%	4
NEC	2	109			
	3	311	20	6.4%	4
	4	69	4	5.8%	0
NED	3	364	55	15.1%	0
	4	81	22	27.2%	0
SAR	1	96	32	33.3%	3
	2	10			
	4	34			
NCA	1	22	3	13.6%	1
	2	2			
TUN	1	9			
	4	2			
TUS	1	18		0.0%	
	2	19		0.0%	

Table 2: Total number of observed LCS discarded dead by the POP by area and quarter.

Area	Quarter	Bignos	Blacktip	Dusky	Hammerhead	Night	Sandbar	Silky	Spinner	Tiger	White	Shark	TOTAL
CAR	1				1			2					3
	2							1					1
GOM	1			2				1					3
	2		1	1			2	1				1	6
	3			1				4		1		2	8
	4		6					9		1		5	21
FEC	1					2		6					8
	2			1									1
	3							1					1
SAB	1							1					1
	2			4		135	1	42				5	187
	3					1		11					12
	4							4					4
MAB	1							1					1
	2					3	1		1				5
	3			2				5					7
	4			1		2				1			4
NEC	3							2		2			4
SAR	1							1		1		1	3
NCA	1							1					1
TOTAL		0	7	12	1	143	4	93	1	6	0	14	**281**

Table 3: Reported effort by the PLL (hooks), estimated number (No. discards) and total weight in kilograms (Weight discarded) of LCS discarded dead, and catch rate for each area/quarter stratum. Catch rates (number of LCS/1,000 hooks) in bold-italic font identify catch rates estimated by the general linear model, shaded catch rates correspond to rates estimated using catch and effort information from the PLL.

Area	Quarter	Catch rate	Hooks	No. discards	Weight discarded
CAR	1	0.147	205,483	30	810
	2	0.085	73,182	6	162
	4	0.000	11,061	0	0
GOM	1	0.049	750,898	36	972
	2	0.094	1,129,902	106	2,862
	3	0.118	871,294	103	2,781
	4	0.448	742,311	332	8,964
FEC	1	0.570	121,438	69	1,863
	2	*0.355*	57,138	20	540
	3	0.192	34,183	7	189
	4	*3.164*	12,830	41	1,107
SAB	1	*0.854*	93,690	80	2,160
	2	8.643	371,062	3,207	83,382
	3	2.478	74,321	184	4,968
	4	*1.878*	33,421	63	1,701
MAB	1	0.147	40,230	6	162
	2	0.371	93,293	35	945
	3	0.699	192,601	135	3,645
	4	0.126	421,266	53	1,431
NEC	2	**0.0002**	95,549	22	594
	3	0.271	254,231	69	1,863
	4	0.000	63,982	0	0
NED	3	0.000	369,670	0	0
	4	0.000	76,807	0	0
SAR	1	0.104	88,459	9	243
	2	**0.001**	7,748	3	81
	4	**0.000**	29,464	0	0
NCA	1	*0.345*	19,588	7	189
	2	**0.000**	1,402	0	0
TUN	1	**0.000**	9,000	0	0
	4	**0.000**	1,200	0	0
TUS	1	**0.000**	17,500	0	0
	2	**0.000**	20,030	0	0

Figure 1: US domestic fishing areas used for the estimation of LCS discards